in the cocaine positive subgroup [Mean±SEM=12.3±0.6 for CUD+ vs. 14.0±0.8 for CUD- vs. 15.7±0.5 for controls], higher aggression especially in the cocaine negative subgroup [Mean±SEM=5.7±0.5 for CUD+ vs. 6.7±1.0 for CUD- vs. 3.4±0.4 for controls], and lower self-control in the cocaine positive subgroup [Mean±SEM=14.1±0.7 for CUD+ vs. 16.0±1.1 for CUD- vs. 17.7±0.5 for controls]. These effects remained significant after controlling (with ANCOVAs) for state depression and other demographic variables that differed between the groups. These results suggest significant differences between healthy control subjects and individuals addicted to cocaine in trait measures of personality. Together, the higher negative emotionality (aggression), lower positive emotionality (social closeness) and lower self-control may predispose the addicted individuals to relapse and compulsive drug use, especially under socially stressful situations. The underlying cognitive and neurobiological substrates remain to be elucidated.

Analysis of the Biological Effects of Aspirated Carbon Nanohorn Particles in Mice Using Scanning Near-Field Ultrasound Holography. *Katherine Venmar* (*Denison University, Granville, OH*); *Thomas Thundat* (*Oak Ridge National Laboratory, Oak Ridge, TN*). Engineered nanomaterials, because of their enhanced physicochemical properties compared to their bulk form, are finding an increasingly important role in many potential commercial applications. However, the health effects of nanomaterials are not well understood or thoroughly investigated. Therefore, more studies are needed to examine different types of nanomaterials and the biological responses they invoke. The purpose of this research was to examine the effects of aspirating single-walled carbon nanohorns (SWCNHs) *in vivo* using mice. Bronchoalveolar lavage (BAL) and blood samples were collected from two experimental groups, the nanohorn exposed, and the control mice. Three mice from both groups were sacrificed 24 hours and 7 days after aspiration. Gross examination of the number of macrophages versus activated macrophages in BAL samples from the exposed and the control mice suggested a possible pro-inflammatory response to the carbon nanohorns. Employing a unique detection technique, Scanning Near-Field Ultrasound Holography, carbon nanohorns were discovered bound to cell membranes, inside cells, and near cells in both the red blood cells and BAL sample cells. The positioning of carbon nanohorns inside the cells not bound to a membrane suggests that they entered the cell through a process other than phagocytosis. Furthermore, the red blood cells (RBC) in all the exposed blood samples exhibited a distorted phenotype. Such distortions could possibly lead to various pulmonary diseases. From their ability to permeate membranes, cause pro-inflammatory responses, and distort the phenotype of red blood cells, it can be concluded that carbon nanohorns may pose a biological threat.

Chronic THC Exposure: Effects on Sucrose Conditioned Place Preference in Adolescent Rats. *Anna Verde* (*State University of New York at Stony Brook, Stony Brook, NY*); *Panayotis* (*Peter*) *Thanos* (*Brookhaven National Laboratory, Upton, NY*). The psychoactive constituent in marijuana Δ9-tetrahydrocannabinol (THC) pharmacologically activates the mesolimbic reward pathways. Similarly highly palatable foods also activate the reward circuitry of the brain. Specifically, administration of THC has been shown to influence the intake of sweet foods. The effect of THC in adolescence hasn't been looked at yet. Adolescence may be characterized as a period when a significant amount of neurobiological and development changes occur. Drug abuse during an early neurodevelopmental period may impact the reward potential and consumption of foods or drugs later in life. Therefore, the goal of the present study was to examine the effect of chronic THC administration during adolescence on the reward potential of sucrose using a conditioned place preference (CPP) paradigm. During the exposure period, 4 week old male Sprague Dawley rats were divided into 3 groups to receive a daily i.p. injection for 3 weeks of either: 1) vehicle (saline) 2) low dose THC (0.75 mg/kg) 3) high dose THC (2 mg/kg). Next, all rats started CPP after the last day of treatment. The CPP timeline encompassed the following: Day 1: Habituation, Days 2–9: Conditioning Phase (10 sucrose pellets on even days and no sucrose on odd days), and Day 10: Test Day. These findings will help gain insight on the impact of chronic THC exposure during a neurodevelopmental period on the subsequent reward potential of natural rewards. Finally these sucrose CPP results will be compared to CPP results to drugs in similar THC pretreated rats (Hwang *et al.*, 2006).

The Role of Bootstrap Resampling to Improve Signal-to-Noise Ratio in PET Images. *John Zabroski* (*St. Joseph's College, Patchogue, NY*); *Jean Logan* (*Brookhaven National Laboratory, Upton, NY*). Positron Emission Tomography (PET) imaging helps determine the effects of genetic variation, disease, behavior, and drug administration on living systems at the cellular level. However, the amount of information gained from these images is limited by noise due to poor counting statistics related to the half-life of the radiotracer used and the amount injected, which is limited by regulations placed on radiation exposure to human subjects. For some radiotracers this noise also limits the ability to create parametric images for each subject since an image is constructed by assigning the biochemical parameter to each voxel. Group parametric images may overcome these factors, eliminating error due to poor counting statistics by using discrete time-frame averaging (DFA) before assigning the biochemical parameter to the group image. However, the statistical significance that would otherwise be obtained through individual parametric images cannot be determined with a group parametric image, because there is only one image per group. To overcome this, bootstrap re-sampling was used to create additional datasets-bootstrap samples. The initial trial used data collected from the PET radiotracer [11C]-Clorgyline (CLG), which binds to the enzyme monoamine oxidase A (MAO-A). Simulated data was generated from the measured plasma input functions using model parameters (K1, k2, k3) derived from a region of interest analysis of the thalamus where k3 represents binding of tracer to MAO-A and K1 and k2 represent transfer between plasma and tissue. By introducing different levels of random noise to this data we can simulate time-activity curves at the voxel level. Using DFA we then attempted to increase the signal-to-noise. For each simulation, standard error was calculated. Also, each simulation was compared to a bootstrapped standard error, with the number of bootstrap samples necessary to obtain a stable estimate of the standard error systematically determined. Our analysis shows that bootstrap resampling plays a useful role in determining statistics associated with the DFA process. Bootstrap resampling was closest to the true value of the voxel at the highest noise level (a = 8.0). Now that we have tested the validity of DFA in conjunction with bootstrap resampling, the next step is to generate bootstrap parametric images, allowing an assessment of the statistical significance of group differences.

Nuclear Sciences

Investigate How Different Operating Conditions or Different Reactors Produce Different Fission Product Nuclides, Using ORIGEN Code. *David Askins* (*Kansas State University, Manhattan, KS*); *Charles Weber* (*Oak Ridge National Laboratory, Oak Ridge, TN*). There are many questions in today's age when it comes to the problem of radioactive nuclear waste. With the several different types of engineered nuclear reactors in existence around the world, there are many varied output nuclides that are generated as a result of the broad range of running conditions in certain types of reactors. To determine the theoretical output nuclides ORIGEN/ARP code was used. It is a sequence in SCALE that serves as a fast and user-friendly method of performing nuclear irradiation and decay calculations, using problem-dependent cross sections. All possible reactor types were run with different variables, such as burnup, average power, fuel assembly, enrichment of fuel, percentage of time the reactor was powered up, and the amount of cycles. Once the variables were plugged in, the nuclide output products were taken and compared to those of the same type of reactor under different conditions, and to those of different reactors under different situations and similar circumstances. They were evaluated by first finding the average amount of a nuclide for a single reactor, and then measured up to different reactors by finding either the percent difference between the two nuclides, or the ratio between them. Each reactor type was compared to each of the other reactor types. Following this, the main differences were identified to recognize trends, if any, in the various output products related to the varying reactors. To accomplish this task, for each reactor, several different cases were run, keeping the burnup value the same, while varying the average power and running period. Following the running of each specific case, an executable file, 71process, was created to output all possible fission-product nuclides and their respective weights in gram-atoms. These results were then used to generate Excel spreadsheets with the ratios of how many parts of a given element are produced by one reactor, as compared to another. These ratios were then analyzed for certain trends of nuclides between reactors. At this time no results have been obtained. With nuclear power becoming ever more present in today's power industry, we are inevitably faced with the problem of spent fuel accumulating. Furthermore, with the ever-present threat of nuclear waste falling into the wrong hands, it is essential to be able to identify where such nuclear waste came from. To achieve tangible results, more research should be conducted.

Characterization of Neutron Spectra from Coulombic Deuteron Breakup. Brad Barquest (*University of California at Berkeley, Berkeley, CA*); Peggy McMahan (*Lawrence Berkeley National Laboratory, Berkley, CA*). A source of tunable, quasi-monoenergetic neutrons is under development at the 88-Inch Cyclotron at Lawrence Berkeley National Laboratory (LBNL). The neutrons are produced through breakup of deuterons in a nuclear coulombic field. As neutrons from both direct nuclear reactions and coulomb-induced breakup contribute to the outgoing flux, characterization of the neutron spectra as a function of deuteron energy, target material and angle are needed to determine the relative contributions from the two channels. 29 MeV deuterons impinged upon a Ta foil, and the residual beam was dumped in an adjacent room. Measurements were taken at 25º, 35º, and 45º with respect to the target in the lab frame, and time-of-flight (TOF) techniques were used to determine the neutron energies. Results demonstrate a decreasing flux with increasing lab angle for neutrons with energy greater than or equal to 10 MeV, which is consistent with coulombic breakup. Further comparison with theory is necessary to determine the extent of direct reaction contributions.

Combating Nuisance Alarms Caused by "Ship Effect" in ^{3}He Based Neutron Detection Radiation Portal Monitors. Elise Buckley, Anna Oliveri (*Juniata College, Huntingdon, PA*); James Ely (*Pacific Northwest National Laboratory, Richland, WA*). The "ship effect" occurs when high-energy neutrons produced by cosmic rays strike bulk materials and produce a burst of neutrons. These ship effect neutrons can present unique challenges in ongoing efforts to interdict illicit nuclear trafficking at border crossings. ^{3}He neutron proportional counters, the neutron detection component in deployed radiation portal monitors (RPM), can generate false positives due to these neutron spikes, leading to cumbersome and time-consuming secondary radiation scans. This work explores methods to mitigate these nuisance alarms through a better understanding of how this effect is manifested in different materials, the role of a target materials' neutron density, and data analysis techniques to account for its effects. We used a mobile RPM equipped with ^{3}He tubes to detect the neutron flux from several commercial products containing naturally occurring radioactive materials (NORM), including ceramic tile, fertilizer, rock salt, cat litter, and lead. We compared the mass density and neutron density of these materials to their neutron count rates, finding a linear relationship between neutron density and neutron flux. High neutron density materials were found to be a greater source of ship effect neutrons. While neutrons from illicit nuclear sources such as plutonium are Poisson in their temporal frequency distribution, those from background are not. We found that ship effect neutrons deviated from a Poisson distribution when binned over 0.1 second time intervals, however if the neutron flux was averaged instead over 2.0 second time intervals the ship effect neutron spikes were washed out, recovering a Poisson distribution. These findings provide underlying knowledge regarding ship effect neutrons emanating from some common bulk materials, and suggest a data analysis algorithm to distinguish between innocent ship effect neutrons and more worrisome neutron-emitting illegal sources.

Fabrication Manual for the Fuels and Applied Science Building. Megan Dixon (*University of Idaho, Moscow, ID*); Jared M. Wight (*Idaho National Laboratory, Idaho Falls, ID*). The Fuels and Applied Science Building (FASB) in the Materials and Fuels Complex (MFC) at the Idaho National Laboratory (INL) is a radiological facility where significant scientific research and development occur. This summer, INL research facilities were scheduled for several inspections in preparation for an upcoming Department of Energy (DOE) safety audit. Groundwork for these inspections included both paperwork and physical preparation which impacted the majority of FASB researchers and postponed the originally planned summer research activity entirely. The majority of the research occurring in FASB is conducted for the Reduced Enrichment for Research and Test Reactors (RERTR) fuel development program. The RERTR program is tasked to convert civilian research and test reactors worldwide from High Enriched Uranium (HEU) to Low Enriched Uranium (LEU). This research includes the development of advanced high-density LEU fuels. The program has developed a uranium-molybdenum monolithic fuel foil and is currently developing techniques to clad the fuel in aluminum. Friction Bonding (FB) is a bonding process used to clad the uranium alloy foils. Friction bonding works by applying pressure with a rotating tool. This generates heat, softens the material, and creates a bond by producing a plastic flow of metal on both sides of the fuel plate. Another cladding process, Hot Isostatic Pressing (HIP), uses high temperature and pressure to bond the metallic fuels to the cladding. Other work for the RERTR program includes development of high-density dispersion fuels using the same type of fuel alloy. The dispersion process consists of many steps including: production of uranium alloy powder, compaction with aluminum powder, and the hot rolling of the compacts in an aluminum frame to form a fuel plate. Process information about the various RERTR projects was acquired from appropriate researchers and compiled to create a poster which will be placed inside FASB to educate visitors about the projects being conducted.

Nuclear Material Shipments: The Challenge of Material Transfers Using Certified Containers. Matthew Duchene (*University of Illinois, Urbana, IL*); Terri Bray (*Argonne National Laboratory, Argonne, IL*). In a continuing effort to develop safe nuclear technology, Argonne National Laboratory and the U.S. Department of Energy (DOE) utilize a variety of approved shipping containers to transport nuclear fuel and radioactive waste to various facilities across the country. As many of these shipping casks become old and outdated, the DOE will decommission a large number of different cask models for safety purposes. The rapid decommissioning of so many containers presents a great challenge for all government and private run institutions. The model T-2 shipping cask, which is used heavily by Argonne for hot cell material movement, is one of the many casks being retired. Due to this development, Argonne will require a new model shipping container to transport irradiated nuclear material from the onsite decommissioned reactors and hot cell facility to other national facilities for storage and waste management. In order to conduct procedures in the future, the Nuclear Operations Division at Argonne must find a certified shipping cask that is not slated to be retired, will be effective in the movement of the laboratory's nuclear material, and does not exceed the structural and safety limits of the laboratory's facilities. After a detailed literature search, the T-3 cask is the best option for offsite material transfers if the material is first relocated from the hot cell to a staging point in the Argonne building 200 M-wing.

Photoelectrochemically Splitting Water Using TiO_2 Nanotubes. Latoya Harrison (*Prairie View A&M University, Prairie View, TX*); Costas Tsouris (*Oak Ridge National Laboratory, Oak Ridge, TN*). Fossil fuels, burned for energy, are polluting the earth's ecosystem. Hydrogen is a non-polluting fuel that could be used, instead of fossil fuels. The question is how one can efficiently produce hydrogen. The purpose of this project is to photoelectrochemically split water to produce hydrogen. The concept is to use light to split water molecules into hydrogen at the cathode and oxygen at the anode. The experimental system used in this study consists of a power source attached to a titania (TiO_2) nanotubes anode and a platinum cathode. Ultraviolet (UV) light irradiation of the anode is used to reduce the amount of electrical force required by the electrolytic process. An aqueous solution containing 1M sulfuric acid completes the circuit. The specific contribution of this work tests the hypothesis that a film of TiO_2 nanotubes synthesized at Oak Ridge National Laboratory can be used as a photoactive anode with improved efficiency. This hypothesis is being tested through a set of experiments using different anodes. We used: amorphous TiO_2, rutile crystalline TiO_2, and anatase crystalline TiO_2 nanotubes. We found that, in all cases, photoillumination of the anode increases the produced current. The TiO_2 anatase crystalline structure produced the highest increased in photocurrent. Higher produced currents led to higher hydrogen production. TiO_2 anatase nanostructures showed the highest photo efficiency, about 0.3 percent, of the total light energy used in the experiments.

A Physical Description of Fission Product Behavior in Fuels for Advanced Power Reactors. Gary Kaganas (*Florida International University, Miami, FL*); Jeff Rest (*Argonne National Laboratory, Argonne, IL*). The Global Nuclear Energy Partnership (GNEP) is considering a list of reactors and nuclear fuels as part of its chartered initiative. Because many of the candidate materials have not been explored experimentally under the conditions of interest, and in order to economize on program costs, analytical support in the form of combined first principle and mechanistic modeling is highly desirable. The present work is a compilation of mechanistic models developed in order to describe the fission product behavior of irradiated nuclear fuel. The mechanistic nature of the model development allows for the possibility of describing a range of nuclear fuels under varying operating conditions. Key sources include the mechanistic FASTGRASS code and the Dispersion Analysis Research Tool (DART). Described behavior mechanisms are divided into subdivisions treating fundamental materials processes under normal operation as well as the effect of transient heating conditions on these processes. Model topics discussed include intra- and intergranular gas-atom and bubble diffusion, bubble nucleation and growth, gas-atom re-solution, fuel swelling and fission gas release. In addition, the effect of an evolving microstructure on these processes (e.g., irradiation-induced recrystallization) is considered. The uranium-alloy fuel, U-xPu-Zr, is investigated and behavior mechanisms are proposed for swelling in the α-, intermediate- and γ-uranium zones of this fuel. The work reviews the FASTGRASS kinetic/mechanistic description of volatile fission products and, separately, the basis for the DART calculation of bubble behavior in amorphous fuels. Development areas and applications for physical nuclear fuel models are identified.

Transportation of Nuclear Fuel Rods in Building 212. *Jason McCall* (*University of Missouri – Rolla, Rolla, MO*); *Terri Bray* (*Argonne National Laboratory, Argonne, IL*). Under a directive from DOE, the Alpha Gamma Hot Cell Facility (AGHCF) in Building 212 at Argonne must empty all nuclear material by 2011. To meet this deadline the DOE has given the Nuclear Operations Division (NOD) four years to transport all the nuclear material out of the AGHCF. Fissile Inventory Management System (FIMS) is a program developed at Argonne with the purpose of tracking all the nuclear material in the AGHCF. FIMS lists information ranging from the composition of a material to the dimensions of that material. This program was used to prepare material for shipments. Shipments of material are transported in aluminum tubes. A conservative number for the amount of tubes that must be shipped is 241; this estimate was generated by careful analysis of the dimensions of the material. The casks Argonne currently uses to ship tubes are the T-2 casks each of which houses twelve tubes. However, the T-2 casks are currently in the decommissioning process, and by the year 2008 the T-2 casks will be allowed for onsite usage only. NOD therefore must find a cask that will replace the T-2 casks and allow the material in the AGHCF to be removed within the DOE's allotted time frame.

Sensitivity Improvement In Low-Profile Distributed Detector Systems For Tracking Sources In Transit. *Tenille Medley* (*University of Illinois at Chicago, Chicago, IL*); *Richard Vilim* (*Argonne National Laboratory, Argonne, IL*). The RadTrac real-time detection and tracking software runs on a laptop computer networked to gammaradiation detectors. A probabilistic estimate for source position is generated by combining measured count rate data with a first-principles stochastic model for the space and time dependence of count rates and knowledge of detector intrinsic efficiency. Recent development work has focused on improving RadTrac sensitivity in lowcount rate situations. A method has been developed for processing count rates by energy according to that part of the energy spectrum with the greatest signal-to-noise ratio. In addition a method has been developed that places constraints on the solution that are physically appropriate when count rates approach background. In both instances experiments with a weak source confirmed the uncertainty in estimated position is reduced.

Similarity of Critical Experiment Using Sensitivity Analysis. *Allison Miller* (*University of New Mexico, Albuquerque, NM*); *Brad Rearden* (*Oak Ridge National Laboratory, Oak Ridge, TN*). Validation of nuclear critical safety calculations is required to establish the relationship between calculated keff values and reality. From the International Handbook of Evaluated Criticality Safety Benchmark Experiments (IHECSBE), critical experiments were examined. Benchmark experiments that were similar in composition to that of the criticality safety model were modeled with the use of the same version of computer code, nuclear data and modeling assumptions as in the criticality safety model. The SCALE 5.1 TSUNAMI -3D is a code in which the sensitivity of the nuclear data is calculated. This sensitivity defines how the keff of a model or system will be affected for a given change in a specific nuclide. The goal was to obtain data for the sensitivity analysis for each benchmark experiment and compare these results to those of criticality safety model. For the purpose of code validation, direct perturbation calculations were preformed. A new prototypic SCALE module is being beta-tested to perform the direct perturbation (DP) calculations, named TSUNAMI -DP. The expectation is that this module will release with SCALE 6 in 2008. TSUNAMI -DP generates the direct perturbation Critical Safety Analysis Sequences (CSAS) files. The CSAS output files are then examined to validate the TSUNAMI -3D sensitivity results. Once it is seen that the TSUNAMI -3D results and the direct perturbation results are within 5% of one another, the sensitivity data files are compared to those of the cask models; using the TSUNAMI -IP module. TSUNAMI -IP generates a final value that shows how similar the two models are. TSUNAMI-IP generates a final value, which states the similarity between the criticality safety model and the benchmark experiment model. The majority of the critical experiments that were modeled were not similar to those of the criticality safety model, and therefore will not be applicable. Continual work is being done to obtain more critical benchmark experiments that are applicable to that of the criticality safety model.

Variance Reduction for Radiation Transport Using Delta-f Methods. *Ian Percel* (*University of Illinois at Urbana-Champaign, Urbana, IL*); *Rick Nebel* (*Los Alamos National Laboratory, Los Alamos, NM*). Radiation hydrodynamics is employed by physicists to describe the behavior of fluids that are strongly coupled to a radiation field. This is particularly important in analyzing astrophysical phenomena. Direct Simulation Monte Carlo is one of the few numerical tools available for solving realistic problems in radiation hydrodynamics. Since M. Kotschenreuther's work in 1988, the delta-f method has dramatically reduced the variance observed in Monte Carlo solutions to problems in plasma physics. Recently, researchers at Lawrence Livermore National Laboratory (LLNL) have considered using a similar technique in radiation transport. The new algorithm being studied at Los Alamos National Laboratory (LANL) includes the LLNL algorithm as a special case. The LANL equilibrium term results from using the standard asymptotic expansion to include diffusion as well as the Local Thermal Equilibrium component that the LLNL algorithm is restricted to. The weighting function is evolved using a difference equation for the total time derivative of the distribution. The connection to the weighting function is established by using a Klimontovich representation of the system. In this research, the proposed change has been formally proven to provide a valid extension of the delta-f method. The derivation also implies the existence of an alternate evaluation method that may provide a check on the diffusion approximation. If efficiency gains observed in plasma physics simulations hold, the new algorithm should show a dramatic improvement over the LLNL algorithm. Specifically, the new algorithm may offer as large a gain in efficiency over the LLNL algorithm as the LLNL algorithm demonstrates when compared with analog methods. A comparison of the two algorithms has not been completed and continuing work should provide a basis for further improvements. This algorithm may offer significantly more accurate radiation transport calculations than have been possible to date. Initial numerical results will be presented.

Semi-Automation of Data Analysis of RTBT Wire Scanners. *Fedrick Reynolds* (*Tennessee State University, Nashville, TN*); *Ted Williams* (*Oak Ridge National Laboratory, Oak Ridge, TN*). The Spallation Neutron Source (SNS) is the most powerful pulsed source of neutrons in the world. SNS consists of a Linear Accelerator (Linac) that accelerates negatively charged hydrogen ions (H-) throughout the various regions of the Linac to approximately 88% of the speed of light. However, the region that is focused on is the Ring to Target Beam Transport (RTBT). In this region, the beam is transported to the mercury target to produce neutrons that are used for research. During the transport, the size of the beam is increased, and to produce the maximum amount of neutrons the beam size and orientation is essential. To ensure that the neutron production is efficient as possible, the analyzation of data from wire scanners in the RTBT is necessary. When analyzing data, it is common to perform the tasks of eliminating outliers and noise caused by various things. These tasks are many times tedious and time consuming. Therefore, the task was to modify an existing program that would make the analyzation less wearisome, and include buttons that would subtract noise and store important values that would be produced from the analyzation. These buttons were created and placed in the program RTBT Wizard, a program that analyzes wire scanner data from the RTBT region of the Linac. These buttons, "Clear Data," "Percent of Range," and "Fit and Store" provides the user with an easy step-by-step process of analyzing data. The "Clear" button clears a table holding data while allowing the user to import another set of data to be analyzed. The "Percent Range" button is used to subtract background noise from being analyzed. This is essential because the background noise can cause the beam size calculations to be thrown off, therefore causing over-adjustments by the Linac operators. The "Fit and Store" button, fits the data with a Gaussian profile and stores the values of amplitude and sigma. These values determine the beam size and within the program the orientation and shape of the beam can be calculated with these same figures. These modifications, while minor on a visible level, were much needed, and will prove to become great assets for the operators.

Reviving and Upgrading of the eP Device. *Idaykis Rodriguez* (*Florida International University, Miami, FL*); *Douglas W. Higinbotham* (*Thomas Jefferson National Accelerator Facility, Newport News, VA*). At Thomas Jefferson National Accelerator Facility, an electron beam is used to probe the fundamental properties of the nucleus. In these experiments, it is essential to know the precise energy of the beam. An important instrument along the beamline to measure the beam energy is the eP device. The device measures the scattered electron angle and the recoil proton angle of an elastic collision. From these angle measurements, the beam energy can be calculated. The eP device components such as computer software, controls, and mechanical parts needed to be upgraded and/or replaced in order for the eP device to be operational again. A research study was conducted of the current hydrogen target and its properties as well as alternate targets for better performance. An analysis was also done on potential changes to the position of the electron and proton detectors for the 12 GeV upgrade because eP can only measure energies up to 5.5 GeV. Calculations show that for the new energy upgrade, electron detectors need to be positioned at 50 above and below the beamline to measure the energy of 11 GeV. Another two proton detectors need to be placed at an angle of 49.20 above and below the beamline to measure energies of 6.6 GeV and 8.8 GeV. With these changes the eP device will measure the range of new energies from 2.2 GeV to 11GeV. From the target research studies it was found that a carbon nanotube mixture with polypropylene could be the ideal target for the eP device because of its high thermal conductivity and its high hydrogen content. The changes made to the eP device demonstrate the importance of continued research and new technologies.

Using the Fissile Inventory Management System to Identify Hazardous Radioactive Materials for Transportation out of Alpha-Gamma Hot Cell Facility. *Mark Sakowski (Purdue University, West Lafayette, IN); Terry Bray (Argonne National Laboratory, Argonne, IL).* During its 43-year history, the Alpha-Gamma Hot Cell Facility (AGHCF) has accumulated 142 kg of uranium and plutonium from previous nuclear reactor research. While research no longer takes place in the AGHCF as a result of its crowded and potentially hazardous workplace, the Department of Energy recently required that the AGHCF be decontaminated and decommissioned in the next four years. All irradiated materials will be transferred from Argonne to appropriate repositories. To carry out this plan, the AGHCF uses a sample tracking database program known as the Fissile Inventory Management System (FIMS) where detailed information of each item in the AGHCF is provided. Consolidating two FIMS data tables provided a single universal data spreadsheet that allowing several analyses of irradiated materials inside the AGHCF; these include volume of fuel elements inside, reactor type and origin, and plutonium and uranium content. Furthermore Argonne uses the T-2 cask for shipments of irradiated reactor fuel elements. The T-2 has strict limits on weight, decay heat, and quantity of hazardous material, so careful planning is necessary. The goal is to retrieve the radioactive material inside the AGHCF and to package the T-2 cask safely and efficiently while maximizing the amount of fissile material to be shipped out to the respective repositories. In addition research for new prototype casks to use for shipments after the T-2's expiration is ongoing.

Applicability of Steady RANS Turbulence Models for Simulation of 7-Pin Wire Wrapped Fuel Pins. *Jeffrey Smith (Kansas State University, Manhattan, KS); David Pointer (Argonne National Laboratory, Argonne, IL).* In response to the goals outlined by the U.S. Department of Energy's Global Nuclear Energy Partnership program, Argonne National Laboratory has initiated an effort to create an integrated multi-physics multi-resolution thermal hydraulic simulation tool package for the evaluation of nuclear power plant design and safety. As part of this effort, the applicability of a variety of thermal hydraulic analysis methods for the prediction of heat transfer and fluid dynamics in the wire-wrapped fuel-rod bundles found in a fast reactor core is composed is being assessed. The work described herein provides an initial assessment of the predictive capabilities of steady RANS turbulence models for this application using the general purpose commercial computational fluid dynamics code Star-CD. A 7-pin wire wrapped fuel rod bundle based on the dimensions of fuel elements in the concept Advanced Burner Test Reactor was simulated using the standard high Reynolds number k-ε model, standard high Reynolds number k-ε model with a Norris & Reynolds two layer wall treatment, the RNG formulation of the high Reynolds number k-ε model, and a six equation algebraic Reynolds Stress Model. The turbulent kinetic energy and velocity magnitude predictions were compared for each case. Among the k-ε formulations, the RNG formulation of the high Reynolds number k-ε model results in the most distinctive change in predicted flow features in comparison to the baseline high Reynolds number k-ε model.

Monitoring Patient Motion During Head Single Photon Emission Computed Tomography Imaging. *Gevorg Stepanyan (Hampden-Sydney College, Hampden Sydney, VA); Stan Majewski (Thomas Jefferson National Accelerator Facility, Newport News, VA).* Patient motion during head single photon emission computed tomography (SPECT) could adversely affect the resolution in diagnostic imaging. The sudden movements compromise the high spatial resolution capabilities of the SPECT imager. To eliminate the image degradation through shifts in the six degrees of freedom, a motion compensation technique is required. The goal of this project is to provide real time tracking with sub-millimeter accuracy of patient motion. The Vicra system uses two infrared (IR) position sensors that track passive IR reflections. The Vicra system was placed to track the retro reflective markers positioned on the head of the patient. This stereo-infrared system provided excellent results from the tracking, of the six degrees of freedom, with errors well within the proposed limits. The 3D root mean square error was 0.101 mm. The full width at half max error was lower then that of the SPECT gamma camera. Analysis of other methods of patient motion tracking suggests that regular stereo-optical tracking systems do not provide the accuracy and repeatability that the Vicra system does. The data obtained using the Vicra system can be utilized for patient motion compensation during SPECT image reconstruction. Image reconstruction allows for an accurate diagnostic of the administered radiopharmaceutical source. The specific goal of this project is to assist in monitoring 131Iodine treatment of glioblastoma multiform using a high resolution SPECT gamma camera.

Thermodynamic Analysis of ITER's Cooling Water System. *Shawn Wachter (Pittsburg State University, Pittsburg, KS); Juan Ferrada (Oak Ridge National Laboratory, Oak Ridge, TN).* ITER, the International Thermonuclear Experimental Reactor, is currently being constructed in Cadarache, France by an international consortium including the United States. FlowITER is a simulations package designed at Oak Ridge National Laboratories to study the operations of ITER's cooling water system. ITER is an experimental magnetic confinement fusion reactor designed to produce plasmas capable of sustaining controlled fusion reactions. It is expected to be the first reactor to produce up to five times more thermal energy in steady state operations than is consumed through auxiliary heating, and is forecast to sustain steady state operations for a 500 second fusion pulse. Water will be used as the cooling fluid in the reactor and will transfer heat, or power, away from the reactor. As it is an experimental reactor, the cooling water system will not actually generate electricity but rather will transfer power to a heat rejection system. The United States is responsible for the design and construction of the cooling water system. The focus of our project is to design a software package capable of accurately simulating the operations of the cooling water system. The simulation platform is FlowJava, which is written in Java, and the participating models are written in Python. The tokamak's coolant subsystems include the Divertor / Limiter system, the Primary First Wall / Blanket system, the Neutral Beam Injector system, and the Vacuum Vessel system. By accurately modeling the behavior of the various cooling systems, problems can be predicted in the design stage and construction delays can be avoided.

Designing and Implementing Graphical User Information (GUI) Components for the Automation of the Analysis of RTBT Wire Scanners' Data. *Karla Ward (Tennessee State University, Nashville, TN); Ted Williams (Oak Ridge National Laboratory, Oak Ridge, TN).* Spallation Neutron Source (SNS) located at Oak Ridge National Laboratory (ORNL) is home to the world's highest-energy-pulsed H-ion particle accelerator. The accelerator sends an intense proton pulse to a heavy atomic nucleus of mercury to produce neutron-scattering. Within the accelerator complex are five different sections that work together to result in this neutron-scattering: the linac, the high energy beam transport (HEBT), the ring, the ring to target beam transport (RTBT), and the mercury target. The Linac accelerates the beam to 90% of the speed of light. The HEBT transports the beam from the linac to the ring. The ring stores the protons and the RTBT transports the beam to the mercury target, which gets bombarded by the beam at 60 times per second. The RTBT region of the accelerator is of particular importance currently because this is where data is taken that relate to the size and horizontal and vertical position of the beam before it reaches the target. Wire scanners perform the process of taking the data from the RTBT and placing it into a file to be analyzed, and with the help of a computer program the operators of the accelerator analyze this data. To speed up the analysis of data from the RTBT wire scanners, the analysis program rtbtwizard was modified to improve and enhance the functionality between the user and the data processing routines. Specifically these modifications included the addition of "Cut, Fit and Store All", "Percent Range", "Noise Subtraction", and "Clear Data Table" buttons into an already existing panel. The activation of these buttons produce a series of actions which include automatic Gaussian fitting, storing analyzed data, finding and eliminating the noise floor, and clearing the data table. These modifications resulted in a more efficient procedure for the operators of the accelerator to analyze the size and position of the beam on the target. This in turn improves the probability that there will be a reduction in activation at the target, damage to the nose cone of the target, and ensure maximum neutron production.

Database Management Systems for the Inventory of Nuclear Materials. *Rebecca Ward (McDaniel College, Westminster, MD); Arthur A. Frigo (Argonne National Laboratory, Argonne, IL).* Argonne National Laboratory observes stringent inventory practices with regards to nuclear materials as promulgated in the Code of Federal Regulations (10 CFR 830, 10 CFR 835). The Department of Energy also provides specific guidelines for complying with the codes and sets forth instructions for transporting, storing, and accounting for nuclear materials of security concern. The ability to ensure the implementation of these policies depends on the accuracy with which the inventory of nuclear materials is maintained. Several privately-developed databases are used to track nuclear material inventories at Argonne. The goal of this project is to provide an in-depth examination of Argonne databases as well as databases developed by other national laboratories and the private sector. This paper recommends a comprehensive nuclear materials database that meets the needs of the user, meets the appropriate information technology requirements, and reliably tracks information about nuclear materials. The following databases are considered and evaluated in detail in this paper: Argonne Chemical Engineering Division (CMT) Radionuclide Inventory Database, Local Area Nuclear Materials Accountability Software (LANMAS), Argonne Fissile Inventory Management System (FIMS), Argonne Waste Management System, and the Argonne Sealed Source Inventory Database (SSID). In addition, a comparable database from Oak Ridge National Laboratory was considered, as well as IsoStock©, a commercial software bundle produced by the Gillett Partnership; however, due to space restrictions, details about these other databases are not reported. Information about each database was gathered through dialogue with the architect and the primary users, as well as from available written documentation. The CMT Radionuclide Inventory Database was found to be the most user-friendly and comprehensive tracking system. With a few improvements, this system could be adopted to serve as the inventory database for all nuclear materials at Argonne.

Criticality Evaluation of Plutonium-239 Moderated by High-Density Polyethylene in Stainless Steel and Aluminum Containers Suitable for Non-Exclusive Use Transport. *Timothy Watson (Rensselaer Polytechnic Institute, Troy, NY); John Scorby (Lawrence Livermore National Laboratory, Livermore, CA).* Research is conducted at the Joint Actinide Shock Physics Experimental Facility (JASPER) on the effects of high pressure and temperature environments on 239Pu, in support of the stockpile stewardship program. Once an experiment has been completed, it is necessary to transport the end products for interim storage or final disposition. Federal shipping regulations for non-exclusive use transportation have an exemption allowance when no more than 180 grams of fissile material are present in at least 360 kilograms of contiguous non-fissile material. This allowance exempts the shipper from the requirement to establish and assign a Criticality Safety Index for a package. To evaluate the general applicability and conservatism of this exemption criterion, a worst-case scenario of 180g 239Pu was modeled using one of Lawrence Livermore National Laboratory's in-house Monte Carlo transport codes known as COG 10. The geometry consisted of 239Pu spheres homogenously mixed with high-density polyethylene surrounded by a cube of either stainless steel 304 or aluminum. An optimized geometry for both cube materials and hydrogen-to-fissile isotope (H/X) ratio were determined for a single unit. Infinite and finite 3D arrays of these optimized units were then simulated to determine if the systems would exceed criticality. Completion of these simulations showed that the optimal H/X ratio for the most reactive units ranged from 800 to 1600. A single unit of either cube material would not reach criticality. An infinite array was determined to reach criticality. A lower loading of 100 g of 239Pu was then considered and found to be subcritical in an infinite array with either Al or steel. The offsetting of spheres in their respective cubes was also simulated and showed a considerable decrease in the number of close-packed units needed to reach criticality. These results call into question the general applicability of current regulations for fissile material transport, which under the modeled circumstances may not be sufficient in preventing a critical system. However, a conservative approach was taken in all assumptions and such idealized configurations would most likely not be achieved in more realistic loadings. Additional modeling should be conducted to verify these findings to ensure the transportation requirements are appropriately conservative.

Hydrodynamics of a Centrifugal Contactor. *Meeckral Williams (Prairie View A&M University, Prairie View, TX); Costas Tsouris (Oak Ridge National Laboratory, Oak Ridge, TN).* Countries producing nuclear energy have an interest in nuclear fuel reprocessing, a chemical procedure that extracts fissile materials such as uranium-233, uranium-235, and plutonium-239 from fission products and other materials in the spent nuclear reactor fuels. The goal is to recycle materials that are useful for further nuclear energy production. Centrifugal contactors are used in many plants for the reprocessing of fissile materials. By the use of centrifugal force, the contactor has the advantages of intensive mixing, rapid phase separation, and chemical separation by liquid-liquid extraction in a single unit operation. Two immiscible fluids of different densities, usually an aqueous and an organic fluid, are fed into the contactor to obtain two-phase mixing and extraction. The objective of this work is to determine flow patterns and dispersion properties, such as drop size distributions, in a four-inch diameter centrifugal contactor. The two fluids used here are water and dodecane at flow rate ratios ranging between 1:5 and 5:1. The total flow rate is on the order of 600 mL/min, and the agitation speed is up to 3600 rotations per minute. Once the dispersion is formed, a sample is taken into a light scattering cell where cetyl trimethyl ammonium bromide (CTAB) solution is initially located. The CTAB is a surfactant that stabilizes the droplets to prevent coalescence. Results of particle size measurements obtained by the LS130 light scattering instrument from Coulter have shown that only small droplets can be measured by this method because large drops escape fast to the top of the cell due to buoyancy, even though the sample in the cell is stirred. Video photography using a camera that operates at fast shutter speed and frame recording was employed to visually observe the dispersion in the contactor through an optically transparent wall. Video images reveal details of the drop size, air bubble entrainment, and flow dynamics of the mixing zone. Video imaging has the advantage of direct visualization of the droplets; however, the disadvantage is that it is difficult to distinguish bubbles from droplets. It is hypothesized that, because the difference in the refractive index is greater for air and water or dodecane than for water and dodecane, air bubbles appear sharper on the video images. Drop size measurements are obtained from the images through a size calibration procedure. The size of drops ranges between 1 μm and 500 μm.

238U Fission Ion Chamber for Neutron Dosimetry at the 88-Inch Cyclotron. *Brent Wilson (University of California – Davis, Davis, CA); Peggy McMahan (Lawrence Berkeley National Laboratory, Berkley, CA).* Neutrons are difficult to detect directly due to a neutral charge; however, there are several different ways to measure neutron flux density indirectly. This paper investigates testing a commercial 238U fission ion chamber to measure neutron flux density, as well as conducting efficiency measurements using two sets of three activation foils (27Al, 58Ni, and 59Co) at different locations to sample beam uniformity at the 88-Inch Cyclotron at Lawrence Berkeley National Laboratory. Fast, monoenergetic neutrons in the energy range of 5 to 30 MeV are under development at the facility through deuteron break-up, for radiation effects testing and cross-section measurements for a variety of applications. Through comparisons with absolute fluxes obtained using activation foils, and energy spectra obtained using the time-of-flight method, efficiency for both monoenergetic and white spectrum neutrons can be calculated. Preliminary neutron flux density measurements indicate 1.44×10^7 neutrons per second per cm^2 per steradian were collected by the fission ion chamber for 30 minutes using a 38 MeV deuteron beam with 50 nanoamps of current. Preliminary activation foil data results indicate the center activation foils received roughly 20% more beam than the side foils, separated by a distance of 1.2 cm.

Physics

Establishing Atmospheric Background Ion Levels for the Stand-Off Detection of Ion Sources. *Marc Penalver Aguila (St. Olaf College, Northfield, MN); Charles Gentile (Princeton Plasma Physics Laboratory, Princeton, NJ).* Airborne ion counts can be used to estimate the source and intensity of combustive and electrostatic activity. To determine the minimum threshold for stand-off detection of ion sources, it is necessary to establish the background levels of ions in the lower atmosphere. Source detection depends on the ability to distinguish between regular background variations and exceptional activity. Natural occurrences such as the diurnal cycle, clouds passing overhead, or changing weather conditions all may contribute to increased ion formation. Gerdien condensers, which draw a constant stream of air through an electric field, were used for sampling atmospheric ions. All samples were taken through the exhaust of a